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PATENT SPECIFICATION

(11) **1 391 377**

(21) Application No. 36978/73 (22) Filed 3 Aug. 1973
(31) Convention Application No. 288 905 (32) Filed 14 Sept. 1972 in
(33) United States of America (US)
(44) Complete Specification published 23 April 1975
(51) INT. CL.[2] F16D 25/063 65/20//F16H 5/00
(52) Index at acceptance
F2C 1C4B2 1C9B2
F2D 2C1A 2C1B1 2C3A 2C3B 2C4B1 2C4B2 2C5B 2D5 2D6A
F2E 2N2A2A 2N2D2A 2N2D6A 2N2E5
F2T 37AX 37E2A
(72) Inventor JAMES RYLEY MARTIN

(19)

(54) MULTI-SPEED TRANSMISSIONS

(71) We, GENERAL MOTORS CORPORATION, a Company incorporated under the laws of the State of Delaware, in the United States of America, of Grand Boulevard, in the City of Detroit, State of Michigan, in the United States of America (Assignees of JAMES RYLEY MARTIN) do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement :—

This invention relates to multi-speed transmissions, and to hydraulically operated pistons of such transmissions.

Many current multi-speed transmissions incorporate clutch and brake-apply pistons machined from rough castings to close tolerances on most of their surfaces. This machining ensures proper fit and proper operation of the piston in the transmission. To reduce cost and weight, sheet metal pistons have been utilized in some transmission designs. Some of these sheet metal pistons are disc-like diaphragms which are fixed at their centres to a support and have a movable outer portion provided with an annular friction surface for engagement with a clutch or brake pack. Other sheet metal pistons have been designed to be mounted for unitary sliding movement in a bore drum or other support, but these pistons are incomplete assemblies without means to support and guide their piston return spring, and they require bore-mounted seals to establish fluid-tight piston apply chambers. Generally, these pistons are complex in construction and are not readily adaptable to current multi-speed transmissions.

This invention is primarily concerned with new and improved constructions of stamped sheet metal pistons in multi-speed transmissions. Broadly, a piston having a shell-like body with inner and outer rims is stamped from sheet metal, with annular inner and outer shoulders formed on one face of the shell on to which are pressed retainers having annular walls connected to give an L-shaped cross-section. In the installed position, one wall of each retainer makes annular contact with the piston shell to space the other wall of the retainer a predetermined distance from the shell, thereby forming annular grooves acting as seal ring retaining grooves. Annular elastomeric lip seals are positioned in the inner and outer grooves respectively to sealingly contact outer and inner walls of the piston bore.

As well as an improved sealing arrangement the stamped piston has new and improved provision for supporting return springs used to move the piston to an "off" position when pressure is relieved from the piston apply chamber. In a first design a spring retainer having a circular arrangement of axially extending spring retaining tabs is welded or otherwise secured to the front face of the piston. A series of springs is mounted and held on these tabs in the installed position. In a second design the face of the piston has an annular groove with offset and arcuately spaced spring pockets formed therein. A plastics spring guide fits in the annular groove and has a projection that fits in the pocket. With the projection extending into the pocket, relative circumferential movement between the guide and the piston shell is restricted. Openings formed in the projections of the spring guide permit passage of the springs therethrough and guide the springs into seating engagement with a plate fixed to the member supporting the piston.

There is a new and improved construction for contacting a multi-plate clutch or brake pack. In one embodiment a contact ring is stamped from a flat metal blank, and is provided with projections extending from one side and curved into a spring-like mem-

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ber with the ends aligned and spaced a short distance from each other. This ring member can be constructed and loaded into the piston and then released so that its expansion force causes the projections to contact an annular wall in the face of the piston shell to releasably hold the ring therein. This facilitates assembly and replacement of the ring if needed. In a second design the outer rim of the shell extends axially from the major portion of the shell to form the contact member.

The appended claims define the scope of the invention claimed. The invention and how it can be performed are hereinafter particularly described with reference to the accompanying drawings, in which :—

Figure 1 is a fragmentary side view of a first embodiment of a multi-speed transmission in accordance with the invention, with part of a transmission cover shown broken away;

Figure 2 is a partial section on the line 2-2 of Figure 1;

Figure 3 is an exploded perspective view of the components of Figure 2, illustrating the first embodiment of the invention;

Figure 4 is an enlarged side sectional view corresponding to a portion of Figure 1 but showing a second embodiment of the invention;

Figure 5 is a sectional view taken generally along the line 5-5 of Figure 1; and

Figure 6 is an exploded perspective view of components generally corresponding to those of Figure 1 but illustrating the second embodiment of the invention.

As is shown in Figure 1 of the drawings, a multi-speed transmission includes a three-element torque converter 10, a change-speed gear unit in the form of a compound planetary gear unit 12, two selectively engageable friction devices in the form of multi-plate clutches 14 and 16, a multi-plate brake 18, two one-way brakes 20 and 22, and two band brakes 25 and 26. These clutches and brakes provide the friction elements required to selectively condition the planetary gear unit 12 for three forward ratios and one reverse ratio drive. The converter, gearing, brakes and clutches and substantially identical to corresponding elements disclosed in our U.S. Patent 3,321,056 (Winchell et al), and operate in the same manner to provide three forward ratios and reverse ratio drive.

The torque converter 10 has an engine-driven impeller 27, a turbine 28 and a reactor 30. The turbine 28 is drivingly connected to a turbine shaft 32 that extends longitudinally along the rotational axis of the transmission. The end of the turbine shaft is splined to a first rotatable drum 34 which forms a housing for the clutch 14. As shown, the drive plates of this clutch are splined to the inner wall of the drum 34, and the driven plates interleaved with the drive plates are splined on the outer wall of a support 38 which in turn is splined to one end of a longitudinally extending intermediate shaft 40.

The multi-plate clutch 14 is arranged to be engaged and released by a hydraulically operated piston assembly 42 that is mounted for longitudinal sliding movement in a cylindrical smooth-walled bore of the drum 34 forming the housing for the piston assembly. This piston assembly 42 comprises a thin-walled annular shell 44 stamped from flat sheet metal stock and having inner and outer annular rims 46 and 48. As is best seen in Figure 3, the shell has an annular channel 50 in its face inwardly of the outer rim 48 to provide space for contact means in the form of a convoluted clutch apply ring 52. A first annular support surface constituted by an outer annular shoulder 56 having a diameter slightly less than the diameter of the outer rim 48 is formed on the back of the shell 44, and an annular lip seal retainer 58 also stamped from sheet metal is press-fitted on to the annular shoulder 56. As shown, the retainer 58 has a longitudinally extending wall that contacts the rim 48 to space a radially outwardly extending wall of the retainer a predetermined distance from the rim 48 and so provide an annular groove for an annular elastomeric outer lip seal 60.

The piston shell 44 is also formed with a second annular support surface generally concentric with the first annular support surface and constituted by an inner annular shoulder 64 of a diameter slightly greater than the inner diameter of the rim 46: an annular lip seal retainer 66 also stamped from sheet metal is press-fitted on to the annular shoulder 64. As shown, the retainer 66 has a longitudinally extending wall that contacts the rim 46 to space a radially extending wall of the retainer a predetermined distance from the rim 46 and so provide an annular groove for an annular elastomeric inner lip seal 68.

The outer and inner lip seals 60 and 68 provide sliding sealing contact with the walls of a bore in the drum so that a pressure chamber is formed when the piston assembly is fitted therein. In the transmission of Figure 1, an intermediate annular lip seal 70 supported within the drum 34 contacts a cylindrical inner wall of the shell 44 to divide the pressure chamber into separate chambers so that the clutch 14 can be engaged with a high or low apply force.

A spring retainer 71, stamped from sheet metal, has a circular base portion secured by projection welding (for example) to the front face of the piston adjacent the inner rim 46. The retainer 71 has a series of

equally spaced tabs 72 which are arranged in a circle and extend longitudinally from its base portion. Mounted on each of the tabs is a helical piston return spring 74. The far ends of the springs 74 are seated in an annular spring support 76 that is secured to the inner hub of the drum 34. These springs provide the return force to move the piston assembly to its "off" position when the pressure in the pressure chamber is exhausted.

The clutch apply ring 52 is made from a flat rectangular blank of sheet metal. The rectangular blank is convoluted to provide circumferentially spaced radially extending projections 80, and is then curled into a circular configuration to form a ring with free ends 82 and 84 spaced a short distance from each other. The front and rear edges of the ring are planar parallel surfaces. As is best illustrated in Figures 2 and 3, this apply ring 52 is a flexible cylindrical member that can easily be constricted and loaded into the piston shell. When the ring is released, the expansion force causes the radial projections 80 to contact an annular wall 86 in the shell 44 forming the outer periphery of the channel 50, to thus retain the ring in the piston shell. This construction facilitates assembly or replacement of the contact ring in the piston shell.

The clutch 16 has driven plates splined to the inside of a clutch housing in the form of a second rotatable drum 88, and drive plates splined to a cylindrical support 90 fixed to the first drum 34. The drum 88 is splined at its hub to a sleeve shaft 91 which is drivingly connected to a pair of sun gears of the planetary gear unit 12. A second hydraulically actuated piston assembly 92 is disposed for longitudinal movement in this drum 88 to effect engagement and release of the clutch 16. This piston assembly 92 is substantially the same as the first piston assembly 42, as can be seen from Figure 1, such that the detailed description of the piston assembly 42 also applies to the piston assembly 92. The drum 88 can be held to prevent it from rotating by a band 26 or by the multi-plate brake 18 and one-way brake 22.

The multi-plate brake 18 has a first set of plates splined to the transmission case interleaved with a second set of plates splined to the outer race of the one-way brake 22, which has its inner race fixed to the drum 88. This brake 18 is arranged to be selectively engaged by a third piston assembly 96 to hold stationary the outer race of the one-way brake 22 so that it can engage to hold stationary the drum 88 and the connected sun gears of the planetary gearset to condition the planetary gear unit for an intermediate drive range. This piston is stamped from sheet metal stock to form an annular shell 98 with a central opening that slidably fits in an annular bore (recess) formed in a centre support 100.

The shell 98 is formed with a forwardly extending outer cylindrical rim 102 that has a planar contact face 104 for engaging the multi-plate brake 18. Press-fitted on an outer cylindrical shoulder 106 formed on the back of the shell 98 is an annular lip seal retainer 108 stamped from sheet metal. This retainer is similar to the retainer 58, and co-operates with the shell 98 to form an annular groove for an elastomeric outer lip seal 110. The shell 98 also has an annular radially extending inner rim 112 and an adjacent inner annular shoulder 114. An annular lip seal retainer 116 similar to the retainer 66 is press-fitted on this shoulder, and co-operates with the inner rim 112 to form an annular groove for an elastomeric inner lip seal 118. The outer and inner lip seals 110 and 118 provide sealing for a pressure chamber 120 which when filled with pressure fluid produces forward movement of the piston for engagement of the brake 18.

In the front face of the shell 98 there is an annular channel 124 with three circumferentially spaced spring pockets 126 formed in a bottom wall of the channel for receiving an annular plastics spring guide 128. The spring guide 128 has a flat ring-like base 130 that fits in the channel 124, and three offset projecting portions 132 that fit in the spring pockets 126. The ends of these projecting portions contact the end walls of the pockets to limit circumferential movement of the guide 128 relative to the shell 98. Each projecting portion of the guide has two cylindrical openings 134 through which respective helical springs 136 extend. As shown, the springs 136 are seated in the spring pockets 126 and extend through the corresponding spring guide opening 134 into engagement with a support plate 140 that is secured to a shoulder of the centre support 100. When pressure is relieved from the pressure chamber 120, the springs move the piston back to the "off" position.

The compound planetary gear unit 12 has a first gearset with an input ring gear 146 drivingly connected to the intermediate shaft 40. This ring gear meshes with planet gears 148 rotatably supported on a carrier 150 which is drivingly connected to a transmission output 152. The planet gears 148 mesh with a sun gear 154 which is splined to the end of the sleeve shaft 91 and is drivingly connected to a sun gear 156 of a second planetary gearset of the planetary gear unit. The sun gear 156 meshes with planet gears 158 rotatably supported on a carrier 160 which is secured to a drum 161 and adapted to be held from rotation by the one-way brake 20 or by a reverse-drive band

brake 29. A ring gear 162 of this gearset is drivingly connected to the output carrier 150.

The various brakes and clutches are applied as in the above-mentioned Winchell et al patent, but using the stamped sheet metal pistons of this invention instead of the cast and machined pistons of the Winchell et al patent, and without alteration of the piston bores or other components of the multi-speed transmission disclosed in that patent.

WHAT WE CLAIM IS :—

1. A multi-speed transmission comprising a change-speed gear unit, a selectively engageable friction device operatively connected to the gear unit for changing the input/output speed ratio of the gear unit, a hydraulically operable piston assembly for effecting selective engagement of the friction device, and a housing for the piston assembly, the piston assembly comprising a sheet metal annular shell member having a pair of generally concentric annular support surfaces formed on one face thereof, an annular retainer secured to each of the support surfaces, each of the retainers having a radially extending wall spaced from the shell member such that the radially extending walls of the two retainers co-operate with the shell member to form inner and outer annular grooves respectively, an annular fluid seal disposed in each of the grooves and extending radially from the shell member into sealing contact with the housing so that the piston assembly and the housing form a pressure chamber therein for receiving operating fluid for the piston assembly, and axially projecting contact means extending from the other side of the shell member for engaging the friction device when operating fluid is supplied to the pressure chamber to move the piston assembly in the housing.

2. A multi-speed transmission according to claim 1, in which the hydraulically operable piston assembly is mounted for sliding movement in an annular smooth-walled bore of the housing, the support surfaces of the piston assembly comprise annular shoulders disposed adjacent inner and outer radially projecting rims respectively of the annular shell member, the annular fluid seals disposed in the respective grooves comprise elastomeric seals extending into sealing contact with the walls of the bore to form the pressure chamber in the housing, the shell member has an annular channel therein between the rims, the contact means comprises a flexible curved contact member disposed in the channel and held therein by its expansion force, and having a forward end with a planar contact surface for engaging the friction device when operating fluid is supplied to the chamber, a spring retainer is fixed to the face of the shell member, and return springs are mounted on the spring retainer for biasing the piston assembly towards a position in the bore in which the contact member is spaced from the friction device.

3. A multi-speed transmission according to claim 2, in which the annular channel formed in the annular shell member is bounded by a cylindrical wall disposed adjacent the outer rim, and the flexible contact member disposed in the channel includes free end portions and is curved into a circular configuration, the contact member being resiliently constrictable into a smaller circular configuration for installation into the channel and being convoluted to form radially extending projections thereon which contact the cylindrical wall to yieldably retain the contact member in the shell member, the contact member having surface means on one face thereof for engagement with the friction device.

4. A multi-speed transmission according to claim 2, in which circumferentially spaced spring pockets are formed in a bottom wall of the annular channel, an annular spring guide is disposed in the channel and has arcuately spaced projections which extend into the spring pockets to limit circumferential movement of the spring guide relative to the shell member, each of the projections has axially extending openings therein, the return springs for the piston assembly are seated in the spring pockets and extend through the openings of the projections, and the annular shell member carries contact means for directly engaging the friction device of the change-speed gear unit.

5. A multi-speed transmission according to claim 4, in which the spring guide is made of plastics material.

6. A multi-speed transmission according to any one of claims 1 to 5, in which the sheet metal annular shell member is stamped from flat stock.

7. A multi-speed transmission substantially as hereinbefore particularly described and as shown in Figures 1 to 3 and 5 of the accompanying drawings.

8. A multi-speed transmission substantially as hereinbefore particularly described and as shown in Figures 1 to 3, as modified by Figures 4 and 6, of the accompanying drawings.

D. H. O. WORKMAN
Chartered Patent Agent.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1975.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

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4 SHEETS

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

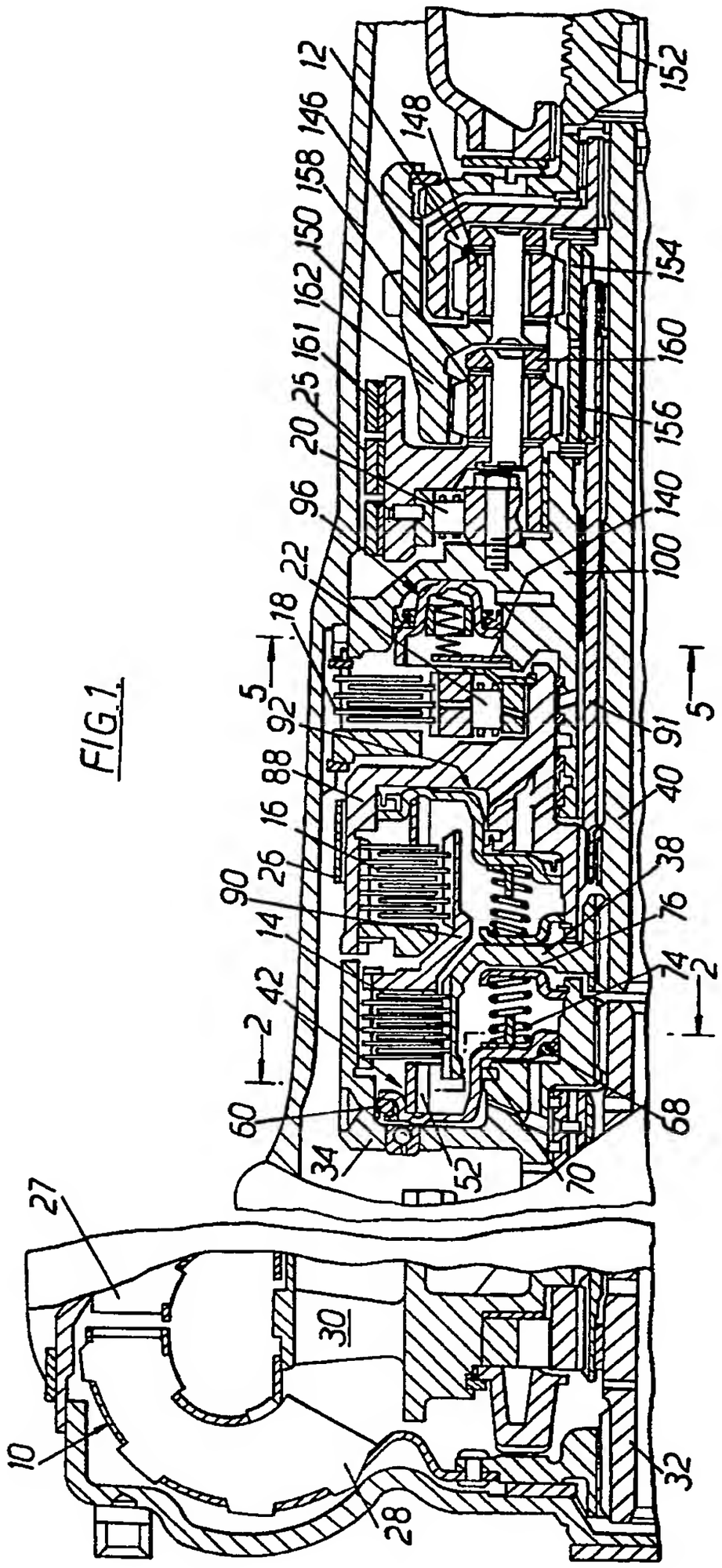

FIG.1

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COMPLETE SPECIFICATION

SHEET 2

FIG.2.

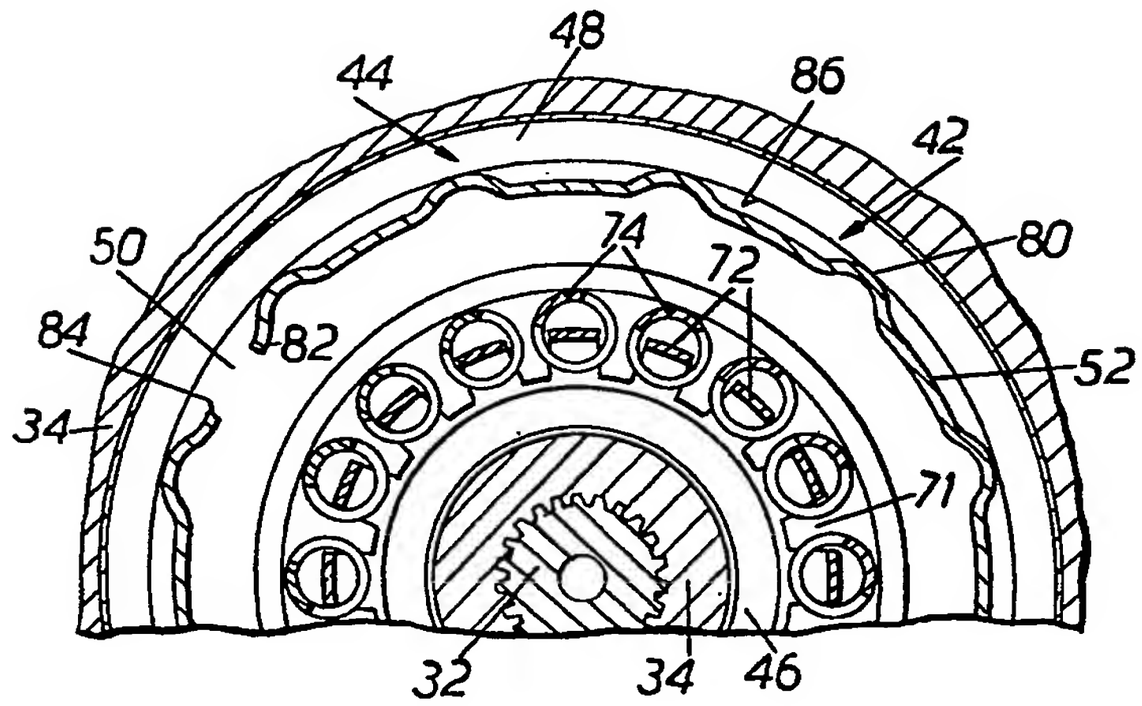
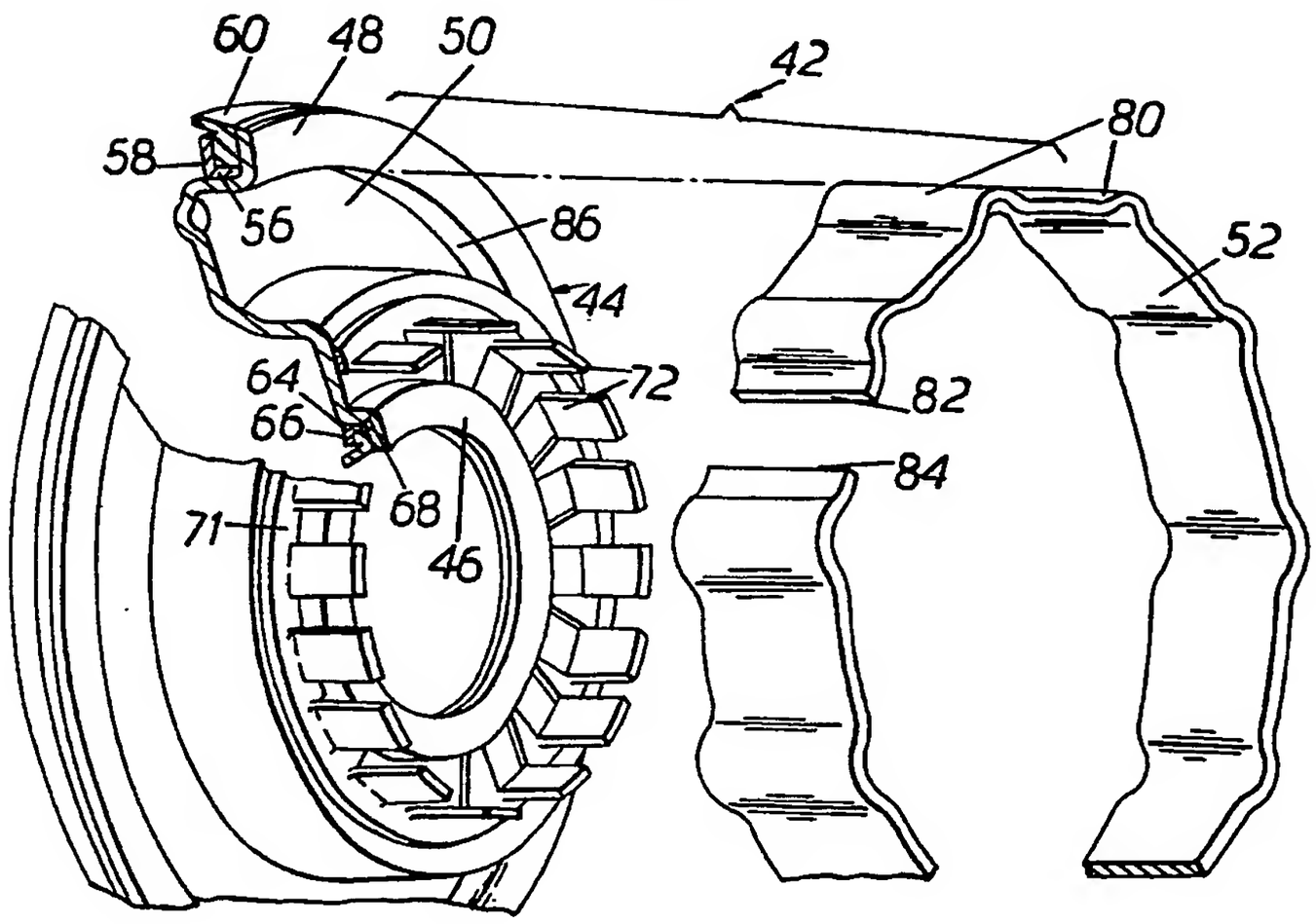


FIG.3.



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COMPLETE SPECIFICATION

SHEET 3

FIG.4.

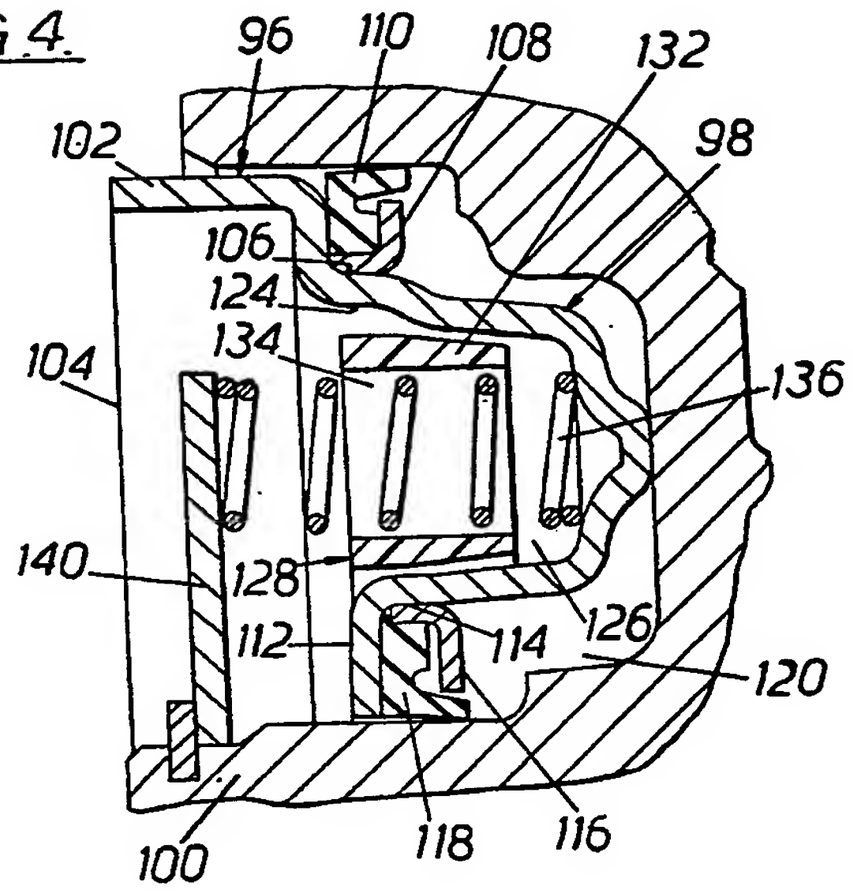
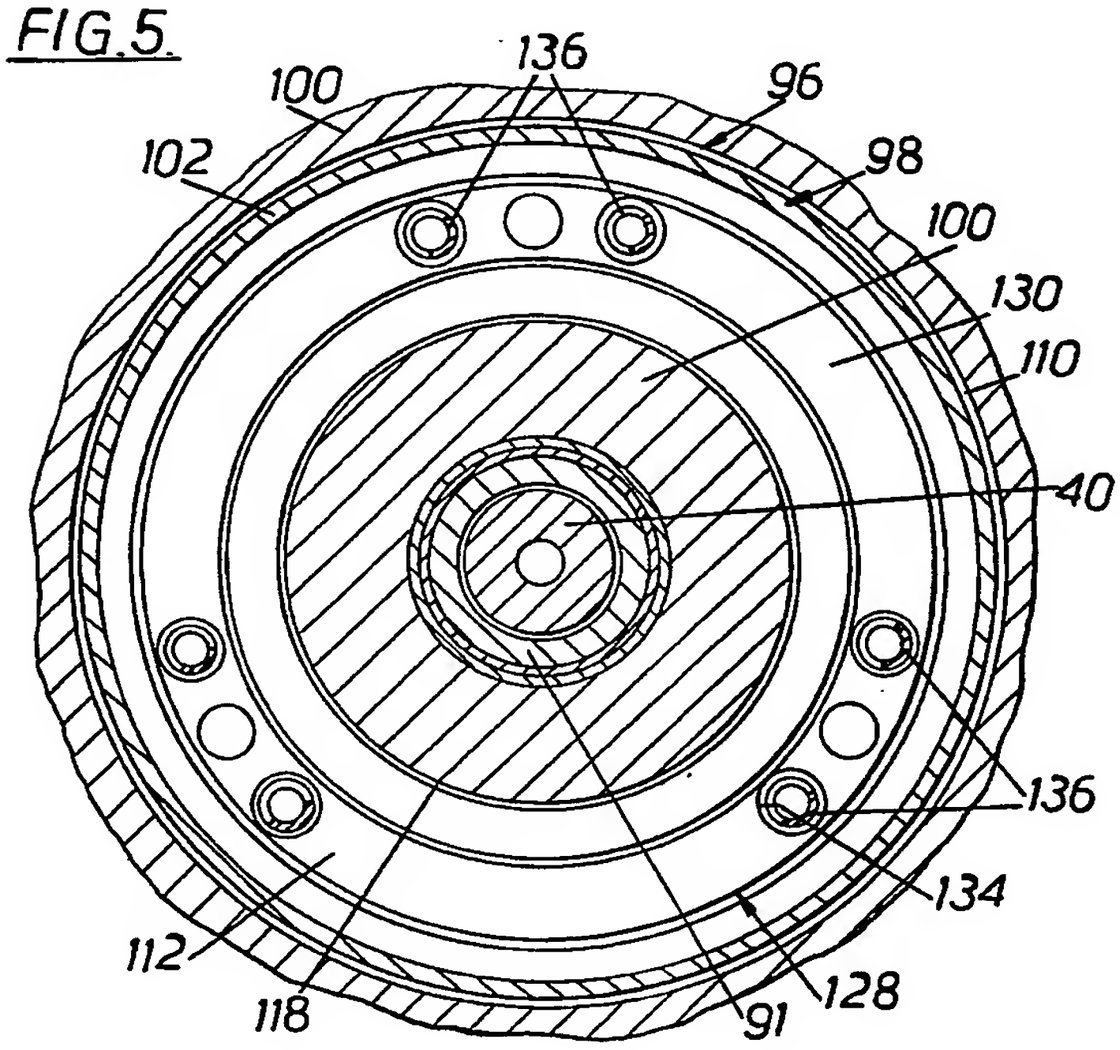


FIG.5.



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COMPLETE SPECIFICATION

SHEET 4

FIG.6.